

BIOGEOGRAPHIC ASSESSMENT AND EVALUATION OF VARIOUS VEGETATION LANDSCAPES IN THE MEDITERRANEAN REGION OF CHILE FOR THEIR ADMINISTRATION AND ORGANIZATION

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One of the main aspects of Applied Biogeography is evaluation, which tries to ascertain the current state of the landscape and vegetation in order to obtain a qualitative assessment. From this point of view, it is an important instrument in territorial administration and organization, an essential tool to acquire knowledge and make decisions regarding vegetation landscapes.

This article is written within the context of more than 15 years of research work, which is based on global methodologies for creating inventories and landscape evaluation that focus on vegetation as a main component for assessment. To date, this methodology has been documented in numerous works (books, articles, chapters in books, documentation and lectures...) and has been applied to several temperate and boreal territories in Europe (Iberian Peninsula, Balkans, Scandinavian Peninsula...). The goal of the current document is to apply this methodology to the Mediterranean region of Chile.

The Mediterranean region of Chile is located between 32°45' and 37°30' South. It is bordered by two high and extensive mountain ranges going from North to South (the Andes to the West, and the Coastal range to the East), contains vast central valleys. As regards geomorphology, there is an interior mountain range to the far North of the region while to the South there are basins and plains with glacial, volcanic and fluvial sedimentation. Due to these volcanic wonders, the soil is rich and highly productive. There we find the most productive agricultural exploitations in Chile (Borgel, 1983). In these central valleys

the Southern Mediterranean climate acquires a certain degree of continentalization and it is generally characterized by contrasting temperatures and rainfall, meaning a cold humid winter and a warm and dry summer. For all these reasons, this climate can be rated under the general classification of Köpen as Csb (moderately warm with rainfall mainly in winter and hot summers). In accordance with this climate, the main native vegetation found is sclerophyll forests and renewable sclerophyll scrub in mountains and slopes of The Andes, while in the middle slopes of the Coastal range there are a larger number of *Acacia caven* in steppes and lower slopes over granite sheets with deep drainage. Information which was already published in a previous article (Quintanilla *et al*, 2012)

Azonality is present in hygromorphic vegetation enclaves with high Andean characteristics in both mountain ranges: sclerophyll and humid forests; endemic palm groves in lower coastal areas; clusters of deciduous oak forests in high mountain areas and conifer forests high in the Mediterranean Andes, which share territory with high steppes. This research work follows a North to South geographic sequence by selecting certain forestal sites in the Mediterranean area of Chile, encompassed by the metropolitan region, fifth region of Valparaiso and sixth region of Libertador General Bernardo O'Higgins. The concrete areas and sectors studied by region were the following:

- Fifth Region of Valparaiso:
 1. La Campana National Park. Las Minas and Granizo Sectors.
 2. El Salto palm grove – Quiteño ravine, Valparaiso.
- Metropolitan Region:
 3. Rio Clarillo Forrestral Reserve. Camino Jorquera.
 4. Cordon de Altos de Cantillana Forestal Reserve, Melipilla. Lo Lisboa Sector.
- Sixth Region of Libertador General Bernardo O'Higgins:
 5. Alto Huemul Private Forestal Reserve. Las Cruces and Las Gordas Sectors.

The core of the research work took place during three visits to Chile (2006, 2009 and 2011), two of which were funded by research project FONDECYT Num. 1095048 that promotes the administration and protection of the native vegetation of Chile. Therefore, the assessment method applied to several landscapes of the country's Mediterranean region had two objectives: study its viability in previously unexamined geographic areas, and provide an evaluation tool to ascertain the quality of the different vegetation landscapes of the Mediterranean region in Chile.

In addition, the following functional objectives are covered:

- A) Obtain partial evaluations to be taken into account in different sectors according to characteristics or issues considered relevant when the need for planification and administration of such territories arises, such as their natural, mesologic and cultural value, as well as any threats.
- B) Consolidate an easy and versatile method to assess and take inventory, with the idea of optimizing its efficacy in the widest possible range of territories.
- C) Assess and analyse the methodology, results and conclusions drawn from the research at scientific events and conferences.

Landscape units and the location of the most appropriate sites for taking inventory were predefined through photo-interpretation and visits to the country, which were followed by taking a biogeographic inventory. To this end, vegetation sites exhibiting the characteristics, type or model of landscape to be assessed and inventoried were selected. From the first visit in 2006 and following an extensive inspection in the country, the creation of a series of inventories consolidating the largest possible quantity of units and, at the same time, their different characteristics was determined. To this purpose, a transect of the main vegetation landscapes of the Mediterranean region of Chile was designed. Sites along this latitudinal cross-section were selected, which were usually located within protected areas ensuring the good condition of the vegetation. As previously mentioned, in addition to selection based on this criterion a limited number of sites were selected because of their particular characteristics. Thus, 17 previously unknown and not inventoried sites were defined and assessed. During the three visits, there were several excursions made to avoid phenological bias.

The first phase of this research, which was reported in a previous article in this journal, outlined the data collection process *in situ* and the posterior formation of the biogeographic inventories of the zones selected to represent each of the vegetation types to be studied. The inventory model used is specific to this project and was designed, tested, contrasted and corrected in an ongoing process by the authors (Meaza, Cadiñanos & Lozano, 2006). Its object is to gather all the surface geographic, environmental and floral data, as well as other parameters related with moss cover, lichens, fungi and the general vegetation in the stratum. In addition, a series of data was gathered which was deemed to be essential for a later evaluation to be made by the forest communities. In this way, the global cover and richness of each layer (COBEST and RIQUEST), the habitat diversity and other modulations which were not of significance at the scale used in this project (FORHAB), the surface area of the homogeneous cover (FORESP), the typology of conservation variation (FORFIS) and the attached cultural, patrimonial and ethnographic values (FORPAT).

The second phase of this research brought us to the evaluation of these vegetation landscapes. The methodology used, the fruit of almost 20 years of work and thought, involves a long process of research and application in the various zones and landscapes. As we have pointed out, our object was to develop a versatile methodology which would produce standardised results that could be easily applied and interpreted, and thus give rise to an appropriate, hierarchical management of the vegetation landscapes in the territories analysed, diagnosed and evaluated.

Our objective then is to present from this overall perspective a coherent, rigorous and practical evaluation methodology, based on simple, flexible and clear guidelines. The proposal is based on different evaluative concepts, which at the same time constitute firm and narrow links with the operational system. Among these, we find those of natural origin, of phytocenotic interest (diversity, representational value, maturity and resilience), those of territorial interest (rarity, endemic character, relict character, finicola) and mesological interest (geomorphological function, climatic, edaphic, hydrological and faunistic). There is also the cultural interest, the ethnobotanical, perceptual and didactic values, varied and differing traditional uses, etc. Finally, there are characteristics related to the endangered nature of specific sites, the priority that must be given to conservation, expressed or determined by three basic parameters, demographic pressure, the degree of accessibility and

transitability, and other alternative threats such as fires, natural risks, acid rain, etc. From all these factors we derive intermediate and final, quantified results which can assist planners with respect to decision-making, and the organization and management of these landscapes.

In all, a total of 17 biogeographical inventories were composed. These make up a highly representative sample of the defining characteristics of the forest and fruit vegetation of the mediterranean area of Chile. This is the first such biogeographic inventory for the evaluation of the vegetation and landscape to be carried out in this region. The method and system of inventory, though initially designed for the communities of the Iberian Peninsula, have turned out to be fully operational in these new areas. This was a major concern of this project.

We calculate that we have registered approximately 90% of the vascular flora which characterizes the nemoral and fruit communities studied. This is no mean contribution to our knowledge of the flora and vegetation of the Mediterranean area of Chile, a vegetation whose structure and composition is not always well known, especially in the case of formations whose natural or residual distribution is more remote.

With regard to the values related with the INNAT, there is a clear gradient between those units which obtain the highest score (the Santiago oak forest and the Mediterranean forest of Chilean palm) and those which obtain the lowest (the Mediterranean sclerophyll scrub and the laurifolia sclerophyll forest in that order). Other units appear with intermediate scores, though it should be pointed out that both the Pellin oak forest and the hydrophilous laurifolia forest get scores very close to 100.

In the values related to cultural aspects, three units appear with very similar scores. In order of preference these are: the Santiago oak forest, the cypress forest in the mountain range, and the Pellin oak forest. These three units show ethnographic, perceptual and didactic values which are very similar. On the other hand, the laurifolia sclerophyll forest obtains the lowest score with only 12 points, followed by the Mediterranean forest of Chilean palm and the Mediterranean sclerophyll scrub.

The sum of the natural and cultural values gives us the Conservation Interest. In this case both the Pellin oak forest and the Santiago oak forest stand out (both obtain more than 170 points). The Mediterranean forest of Chilean palm appears in third position with more than 150 points. The lower positions in this evaluative criterion are occupied by the Mediterranean sclerophyll scrub which is below 100 points while the laurifolia sclerophyll forest is just above this score.

Finally, the priority of conservation registers final values in which the Mediterranean forest of Chilean palm stands apart. This formation shows special characteristics since, at the moment, it is not in any way protected, while the other units inventoried and evaluated are all in protected sectors. These forest sectors with palms in the region of Valparaiso should be immediately protected given that they embody very interesting values and are subject to great pressure and systematic fires. The score allotted to them is very high (above 3500 points), way above all other values. This is in fact the highest score registered in all the inventories carried out so far. The Pellin oak forest, the laurifolia sclerophyll forest and quite close to them the cypress forest in the mountain range and the laurifolia hydrophilous forest also obtain high scores, following the order in which they are listed. It must be pointed out that the priority of conservation in all these cases is very much influenced by the existence of another, very clear threat, fire. (Castillo & Quintanilla, 2007). All the cases we have

mentioned, especially those with pyrophyte plants, such as the cypress forest of the mountain range or the sclerophylls, both the hydrophilous variety and especially the sclerophyll variety, are generally burnt every few years (Pedraza, 1986).

At the opposite extreme we find mediterranean sclerophyll scrub, with a very modest score just barely above 500 points. In this the risk of fires is even higher, but the low points it accumulates in the other parameters and subcriteria lead to a very low overall score.

Finally, we must point out that in the context of this research work there are extreme and contrasting evaluations in relation with units and spaces studied by our team at a European level and also in Chile. Thus, between the Mediterranean palm forest and the sclerophyll Mediterranean scrub there is a distance of 3000 points no less.

By way of comparison between the data obtained from Mediterranean Chile and data collected by our team in European territory, none of the units analyzed for this last geographic measure reached 3000 points. Furthermore, there are definitely no extreme differences between the units. As an example, in the Mediterranean region of the Iberian Peninsula the *Quercus pyrenaica* oak grove can reach 1430 points, the *Quercus faginea* gall-oak grove 1380 and the *Quercus rotundifolia* holm-oak grove 1365. In other Iberian sectors, such as the Atlantic area, the *Quercus suber* cork oak grove can reach 2623.9 points, *Populus tremula* around 2384.5, the *Quercus robur* oak grove 2383.5 and the *Ulex europaeus* heath scrub 1555 points.

Both the inventories as well as their corresponding evaluations, which will be presented in successive articles, will serve for the achievement of the objectives stated by FONDECYT project 1095048 for the protection and management of the native vegetation of Chile, because they represent the indispensable basis for the follow-up and knowledge of their response to fire, of to what extent the units studied have more or less accelerated dynamics for recovery and regeneration after the frequent fires which unfortunately ravage the natural communities of Mediterranean Chile. It has also been possible thanks to the work done within the research team «Sustainable Landscape and Territory Planning and Management» (Lurralde-on) code (GIU 1007).